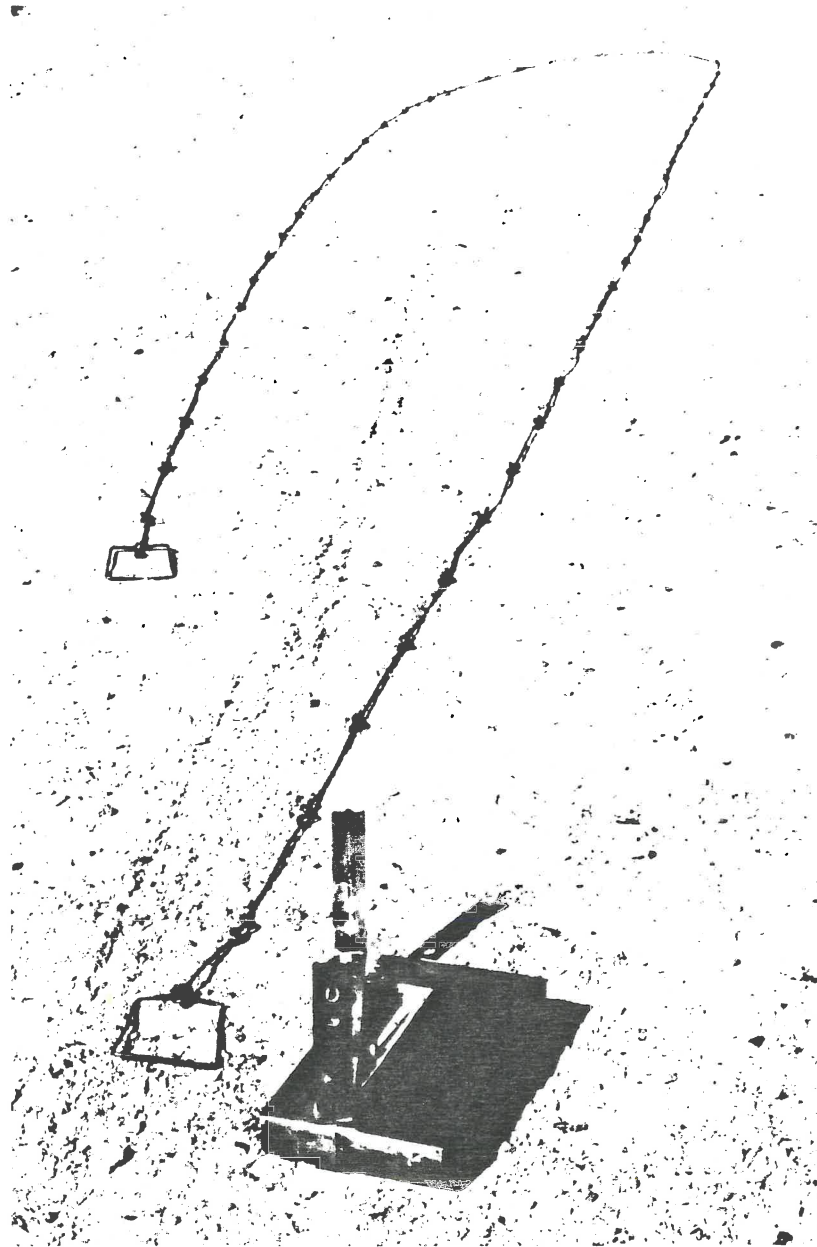


**Eleazar Wheelock's  
Surveying Instruments  
A Historical View**



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History 12  
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Perhaps the oldest scientific artifacts in the possession of Dartmouth College are the surveying instruments that were originally used by Eleazar Wheelock when he first came to New Hampshire in 1769. Two of these instruments are currently on display in the Wilder lobby, his Gunter half-chain and semi-circumferentor which were used, respectively, for measuring the distances and angles involved in basic surveying of the area.

The **surveyor's chain**, or **Gunter chain**, is a unit of measurement which is equivalent to 66 feet. A chain consists of 100 links, each about eight inches long; groups of 25 links are called rods. This unit was the standard unit for measuring distance and area, with ten square chains being one acre, and 80 chains measuring one mile. The chain was physically a series of straight pieces of iron wire, looped at the ends to connect them together (Fig. 1). More recently, flat steel tape has been used for chains. Two men could quickly measure distance through rough terrain with a chain and eleven stakes<sup>1</sup>.

A **circumferentor** was a device used to measure angles with respect to the magnetic meridian; these measurements, combined with those from a chain, completely defines the surveyed area. A full circumferentor consisted of a (usually) brass circle marked off in degrees, a centered

compass for orienting the device, and movable sights (or **alidade**) for sighting along the survey line (Fig. 2). The angle could then be easily read.<sup>2</sup> A semi-circumferentor was only a semicircular device; indeed, 180° is sufficient for measuring most angles (Fig. 3).

The instruments owned by Eleazar are labeled in the display as a Gunter half-chain and a graphometer; Brown and Rieser describe it correctly as a semi-circumferentor,<sup>3</sup> which is verified by careful inspection (Fig. 4). A graphometer is a device used to measure vertical angles, or azimuth, while circumferentors are for horizontal angles.

good point

Bezaleel Woodward, one of the first professors of Dartmouth College and heavily involved in the school's founding, probably did most of the surveying required, using these particular instruments. These tools were no doubt heavily used during that period. As a professor of mathematics, his problems in geometry and trigonometry commonly consisted of problems involving land measurement.

why?

In 1616 an English surveyor named Aaron Rathborne devised a measuring chain, based on his own measurement system. This replaced the old system, probably solid wooden or metal rods which lay on the ground. A chain devised by astronomer Edmund Gunter in 1620, was of similar

design, but introduced the measuring system that has persisted to this day.<sup>4</sup> Both chains were used in the seventeenth century, but by the end of the century Gunter's version had become the accepted standard. The chain has developed a little in form, from iron links to steel tapes, but the units have been used consistently throughout England and the United States for measuring land until the twentieth century. The use of the chain and link system is kept alive in intercollegiate woodsmen's competitions.<sup>5</sup>

Angular measurement devices, particularly the astrolabe, had been around for a long time before Philippe Danfrie developed the graphometer in 1597 (Fig. 5). This was a device for measuring azimuthal angles; several other devices of this style were developed during the seventeenth century for this purpose. The theolodite measured a combination of azimuthal and horizontal angles, and the circumferentor was a very simple, portable device for measuring horizontal angles. John Norden first introduced the circumferentor in England, and it was not long before the plethora of instruments had been reduced to a few basic models.<sup>6</sup> John Love, for example, decided that the chain and circumferentor were best suited for use in the wooded lands on America.<sup>7</sup> The circumferentor was used continuously in the 17th and 18th centuries, but near the end of the 18th century, many surveyors advocated the use of the chain only for

surveying, eliminating the use of angle measurement devices.<sup>8</sup>

As time went on, there was an increasing need for accuracy in the measurements of surveyors. Land was being divided at an ever-increasing rate, more complex construction was being attempted, more detailed maps were necessary, and more careful economic records were needed. The technological innovations of the instrument makers allowed the devices to become more accurate, more consistent, easier to use, and more easily obtained to reflect the changing nature of the surveying world. Devices like the circumferentor were steadily improved, and new instruments were continually invented. The chain and circumferentor are no longer used; modern surveyors use the transit, with its improvements in telescopic sighting, mount hardware, and adjustments.

It can be seen that the set of instruments used by Bezaleel Woodward were simple and fairly crude. The chain was only a half-chain, or 50 links, and the semi-circumferentor does not seem to be very well made, given its use in the later part of the 18th century. This was quite possibly all that they needed in the north woods of New Hampshire, and they no doubt served the purposes of the young college for many years.

## Footnotes

<sup>1</sup> Baker, Chapter 1.

<sup>2</sup> Smart, pp. xv-xvi.

<sup>3</sup> Brown and Rieser, p. 9.

<sup>4</sup> Richeson, pp. 108-109, 141.

<sup>5</sup> Intercollegiate woodmen's competitions were started in 1947 by C. Ross McKenney, Dartmouth College Woodcraft Advisor, to preserve old logger's skills and traditions. One of the events at these meets is the "chain throw", which consists of coiling a 200-link chain and tying it with a type of twist known as the "throw"; the best competitors can do this in 45 seconds. (I have competed in this event for three years.)

<sup>6</sup> Richeson, p. 139.

<sup>7</sup> Richeson, p. 128.

<sup>8</sup> Richeson, p. 153.

but is this  
related to  
the surveyor's  
chain?

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Good Bibliography

A nicely-written essay, David.  
Does Kuhn's essay have any  
relevance to the surveying  
apparatus? Are they tools of  
science or something else?

A-

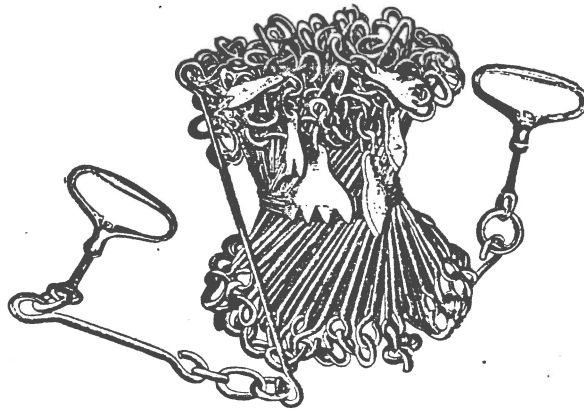
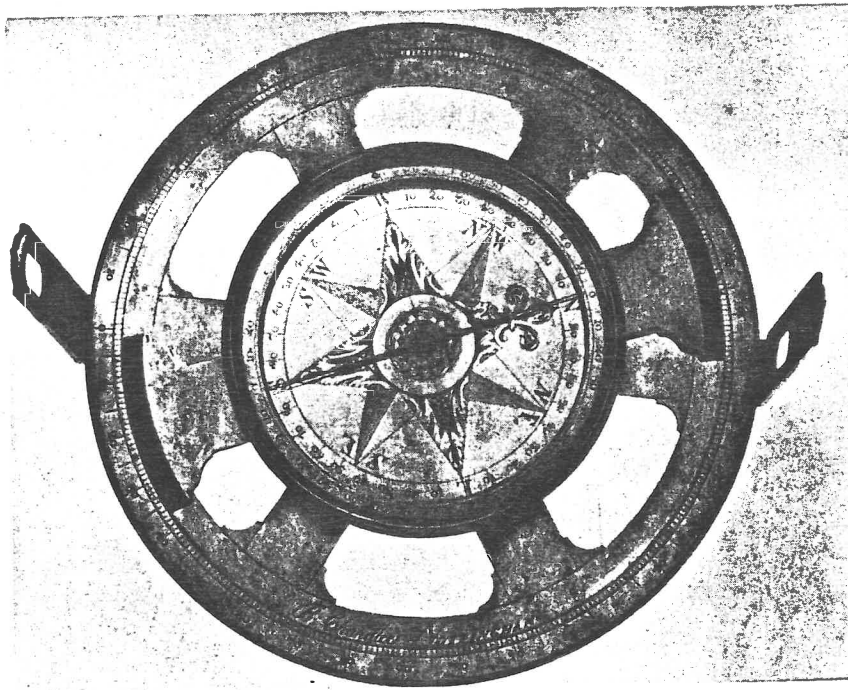


Fig. 1  
Gunter Chain

Fig. 2

CIRCUMFERENTOR

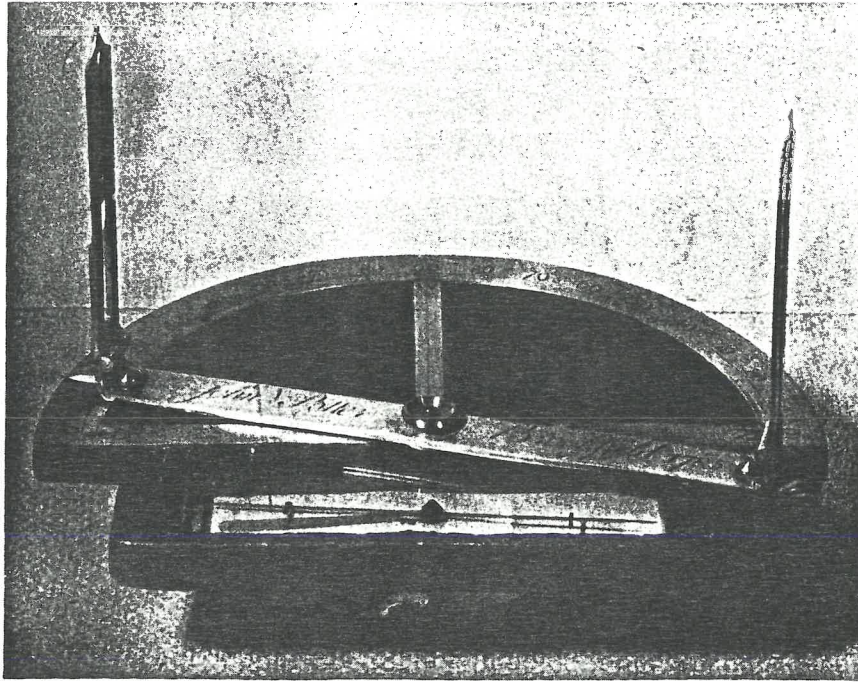


Photograph Courtesy Penrose R. Hoopes  
Philadelphia Pennsylvania

An instrument used by surveyors for taking angles. It consists of a graduated brass circle graduated in quadrants, a set of sights revolving around the same center as the magnetic needle which is suspended above the center of the circle. The sights being directed to an object, the angle which it makes with the magnetic meridian is noted. The sights are then directed to the second object, and the angle it makes with the same meridian observed in like manner. The difference or sum (as the case may be) of the two observed angles gives the angle between the two objects. Also called circumventor and land-compass.



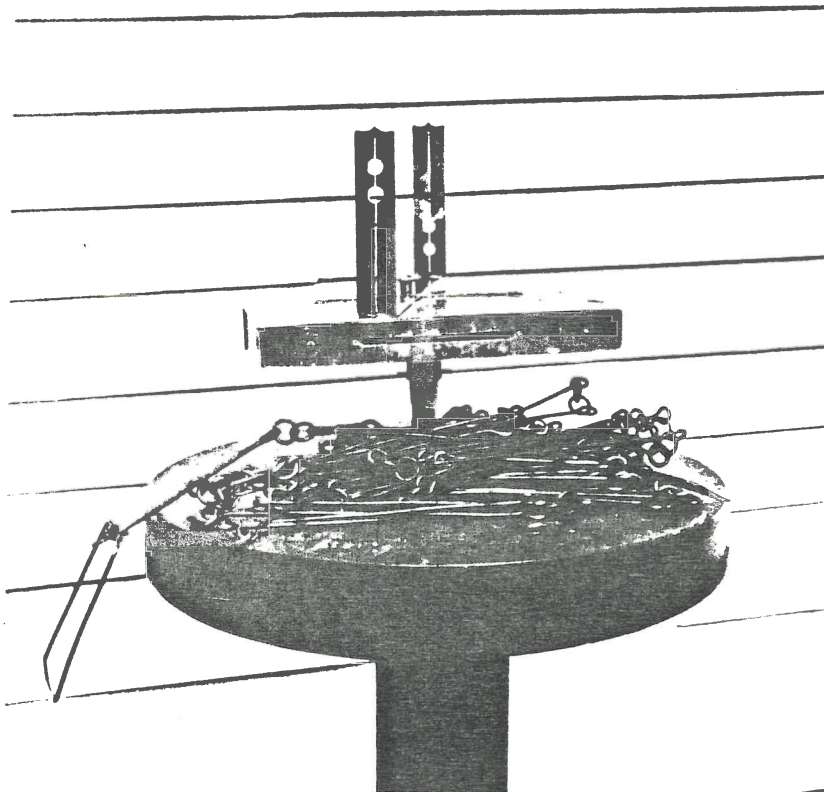
SEMI CIRCUMFERENTER



As its name implies, it is half a circumferenter with the magnetic needle on the side opposite the arc of 180 degrees.

Fig 4

Wheelocks  
Instruments



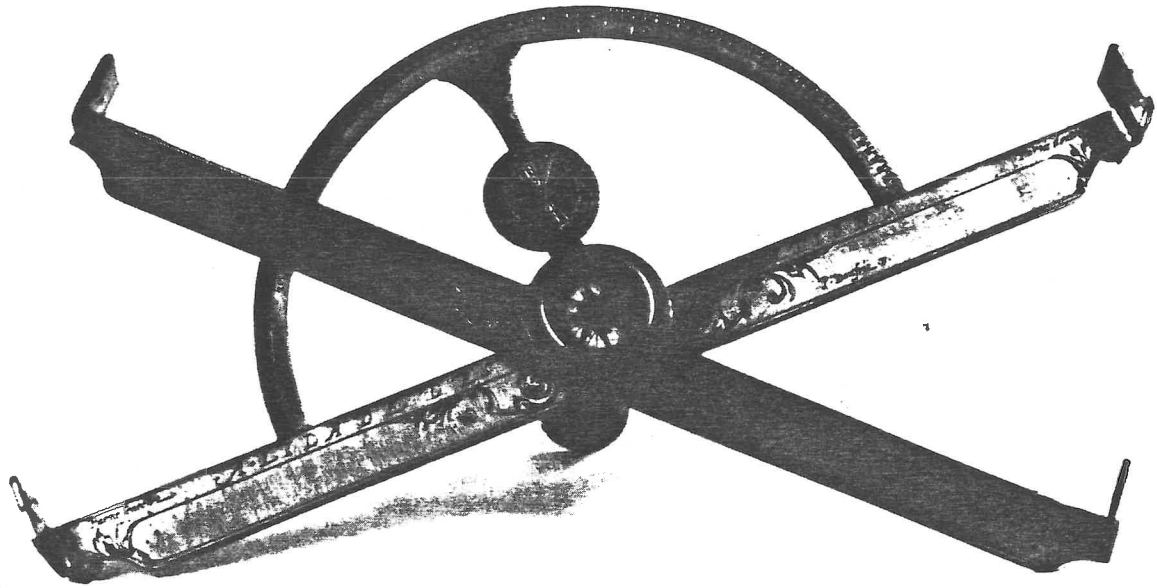


Fig. 5 Dantrie's Graphometer.